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PARASITIC HELMINTHS OF SIX SPECIES OF HAWKS AND FALCONS IN FLORIDA

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Abstract.—Six species of hawks and falcons collected in Florida were examined for helminth parasites from 1971-87. A total of 38 helminth species (15 digeneans, one cestode, 20 nematodes, and two acanthocephalans) was recovered from the red-shouldered hawk (*Buteo lineatus*), red-tailed hawk (*Buteo jamaicensis*), broad-winged hawk (*Buteo platypterus*), sharp-shinned hawk (*Accipiter striatus*), Cooper's hawk (*Accipiter cooperii*), and American kestrel (*Falco sparverius*). The red-shouldered hawk harbored the most species per infected host ($\bar{x}$ = 5.8) while the American kestrel harbored the least ($\bar{x}$ = 1.7). One helminth species was classified as a host specialist and 16 species as generalists in raptors. Euryphagic host species such as the red-shouldered hawk and broad-winged hawk harbored more helminth species than more specialized feeders such as the red-tailed hawk and Cooper's hawk. Helminths were not implicated as the cause of death in any of the hosts examined.

Key Words: *falcons; Florida; hawks; helminths; parasites.*

Helmintos parásitos de seis especies de aguiluchos y halcones en Florida

Resumen.—Seis especies de aguiluchos y halcones colectados en Florida, fueron examinados en busca de parásitos helmintos desde 1971 a 1987. Un total de 38 especies de helmintos (15 digeneanos, un cestódo, 20 nemátodos y dos acantocéfalos) fueron obtenidos de *Buteo lineatus, Buteo jamaicensis, Buteo platypterus, Accipiter striatus, Accipiter cooperii* y *Falco sparverius. Buteo lineatus* albergó la mayoría de las especies por hospedero infectado ($\bar{x}$ = 5.8). Una especie de helminto fue clasificada como especialista y 16 especies como generalistas en rapaces. Los helmintos no estuvieron implicados en las causa de muerte de ninguno de los especímenes examinados.

[Traducción de Ivan Lazo]

Perhaps because of their protected status under federal law, very little information is available on the parasites of hawks in the United States. Most early studies on raptor helminths focused on the taxonomy of specific groups such as trematodes (Denton and Byrd 1951, Schell 1957, Dubois and Rausch 1950), cestodes (Freeman 1959), nematodes (Schell 1953), or acanthocephalans (Nickol 1983). A report by Taft et al. (1993) on the helminths of 10 species of hawks in Minnesota and Wisconsin is the only paper which lists the overall prevalences and intensities of helminths in hawks in North America.

Since 1971, a large number of dead or dying raptors have been submitted to the Department of Infectious Diseases at the University of Florida, Gainesville, for determination of the cause of death. In this paper we report on the helminths of six species of hawks and falcons.

Methods

Sixty-one birds obtained from 19 counties in Florida between December 1971 and March 1987, were examined. Causes of death included collisions with vehicles, collisions with wires, poisoning, and gunshot wounds. Most birds were found dead, but a small, number of birds found alive with injuries too severe to be treated had to be euthanized. Carcasses were frozen within 4 hr of collection or death, transported to the laboratory, and later thawed and examined at necropsy.

Techniques for recovering, fixing, staining, and examining helminths followed Kinsella and Forrester (1972). Terminology follows Margolis et al. (1982) with prevalence defined as the number of individuals of a host species infected with a parasite species divided by the number of hosts examined, and mean intensity defined as the total number of individuals of a parasite species divided by the number of hosts infected with that species. Voucher specimens of helminths were deposited in the Harold W. Manter Laboratory of the University of Nebraska State Museum (Accession Nos. 36883-36894, 36896-36906, 36930-36932).

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RESULTS AND DISCUSSION

Thirty-eight species of helminths (15 digeneans, one cestode, 20 nematodes, and two acanthocephalans) were found. In Table 1 the prevalences and intensities of infection of helminths from the red-shouldered hawk (*Buteo lineatus*), red-tailed hawk (*Buteo jamaicensis*), and broad-winged hawk (*Buteo platypterus*) are listed. The same data for the sharp-shinned hawk (*Accipiter striatus*), Cooper's hawk (*Accipiter cooperii*), and American kestrel (*Falco sparverius*) are given in Table 2. The number of helminth species per infected host varied from one to eleven ($\bar{x}$ = 2.5), with 19 birds free from helminths. In Table 3 we give the number of species per host for the four hosts with sample sizes of five or more. The red-shouldered hawk harbored the most species with a mean of 5.8 species per infected bird (range 1–9), while the kestrel averaged only 1.7 species with no bird having more than three species. The red-tailed hawk and sharp-shinned hawk were intermediate between these extremes.

No one species of helminth was found in all six hosts. Three species of intestinal digeneans (*Strigea falconis, Neodiplostomum americanum, N. attenuatum*) and one species of nematode (*Procyrnea mansioni*) were found in five host species. Nematodes identified as *Physaloptera* sp. were found also in five host species, but many were larvae or immature adults and may represent more than one species. No species demonstrated the high prevalences and intensities usually associated with the concept of "core" species in helminth communities (Bush and Holmes 1986).

Previous workers on helminth communities in lesser scaup (*Aythya affinis*; Bush and Holmes 1986) and shorebirds (Edwards and Bush 1989) have categorized helminth species as specialists, generalists, or cosmopolitan. Specialists were defined narrowly as having the bulk of reproducing adults found only in a single host species or having been reported from a single host species. Generalists are those reported from a wide variety of related species, and cosmopolitan species those found in at least two vertebrate classes.

By these definitions, only one species found in Florida, *Parastrigea tulipoides*, can be considered a host specialist. This species was described from the red-shouldered hawk in North Carolina by Miller and Harkema (1965) and was also found in Florida only from the red-shouldered hawk. Two species can be considered as cosmopolitan: *Echinostoma trivolvis*, reported from many species of birds as well as muskrats (Huffman and Fried 1990), and *Baschkirovitrema incrassatum*. Our record of *B. incrassatum* in a red-shouldered hawk is extremely unusual since this trematode has been reported previously only from otters (*Lutra* spp.) in Europe and North America (Forrester 1992).

The remaining species could be classified as host generalists. This category could be subdivided into raptor generalists, reported from a variety of hawks (and occasionally owls), but not other birds; and true generalists, reported from other orders of birds, including waterfowl and passerines. In Table 4 we list helminth species by category, with 16 classified as raptor generalists and nine as generalists in birds. Helminths not identified to species were excluded because their host relationships were unknown.

Cestodes were extremely rare in our sample, restricted to single infections of *Cladotaenia globifera* in a red-tailed hawk and a broad-winged hawk. Freeman (1959) found only 12 of 2350 rodents that can serve as intermediate hosts infected with this tapeworm in Canada. No infections of *C. globifera* have been found in 714 Florida rodents of five species (Kinsella 1974, 1988, 1991), so population densities in intermediate hosts appear to be even lower than in Canada.

Hawks are one of the few groups of birds that are hosts to both subgenera of the nematode genus *Tetrameres*, which parasitize the proventricular glands. The species of the subgenus *Tetrameres* that we found in the red-shouldered hawk appears to be the same as that described by Mollhagen (1976) from the same host. However, since Mollhagen's dissertation was never published, the species has no taxonomic validity. We also found an undescribed species of the subgenus *Microtetrameres* in the red-shouldered hawk and Cooper's hawk.

Bosakowski and Smith (1992) studied the comparative diets of sympatric raptors in the eastern deciduous forest, including four of the hawks we studied (red-shouldered, red-tailed, broad-winged, Cooper's). The red-shouldered hawk exhibited the greatest food-niche breadth, including in its diet frogs, turtles, fish, crayfish, and small mammals. Its euryphagic diet undoubtedly contributes to the richness of its helminth fauna in comparison to that of the other hawks. The broad-winged hawk was nearly as euryphagic as the red-shouldered hawk, and, although only one broad-winged hawk was examined in this study, it harbored 11 species of helminths.

Table 1. Parasitic helminths from red-shouldered, red-tailed, and broad-winged hawks in Florida.

Helminth	Location in Host[a]	*Buteo lineatus* N = 18 Prevalence Inf.	%	Intensity Mean	Range	*Buteo jamaicensis* N = 13 Prevalence Inf.	%	Intensity Mean	Range	*Buteo platypterus* N = 1 Prevalence Inf.	%	Intensity Mean	Range
Trematoda													
Strigea falconis (Szidat 1928)	SI	—	—	—	—	8	62	447	18–1579	1	100	16	16
Neodiplostomum americanum (Chandler & Rausch 1947)	SI	3	17	160	35–234	3	23	4	1–7	1	100	1	1
Neodiplostomum attenuatum (Linstow 1906)	SI	10	56	102	6–1022	6	46	66	7–228	1	100	165	165
Neodiplostomum pearsoni (Dubois 1962)	SI	—	—	—	—	—	—	—	—	1	100	5	5
Ophiosoma microcephalum (Szidat 1928)	SI	6	33	182	2–461	2	15	4	1–7	—	—	—	—
Parastrigea tulipoides (Miller & Harkema 1965)	SI	4	22	7	2–15	—	—	—	—	—	—	—	—
Platynosomum illiciens (Braun 1901)	L	1	6	7	7	—	—	—	—	—	—	—	—
Brachylecithum rarum (Travassos 1917)	L	5	28	7	3–18	—	—	—	—	—	—	—	—
Baschkirovitrema incrassatum (Diesing 1850)	SI	1	6	15	15	—	—	—	—	—	—	—	—
Microparyphium facetum (Dietz 1909)	C	2	11	2	1–2	—	—	—	—	—	—	—	—
Echinoparyphium sp.	SI	—	—	—	—	1	8	1	1	—	—	—	—
Cestoda													
Cladotaenia globifera (Batsch 1786)	SI	—	—	—	—	1	8	10	10	1	100	2	2
Nematoda													
Capillaria falconis (Goeze 1782)	SI	10	56	2	1–7	4	31	5	1–12	—	—	—	—
Capillaria contorta (Creplin 1839)	E	4	22	1	1–2	2	15	3	1–4	—	—	—	—
Cyathostoma americana (Chapin 1925)	T	—	—	—	—	1	8	1	1	—	—	—	—
Desportesius invaginatus (Linstow 1901)	E	—	—	—	—	3	23	3	1–5	1	100	4	4
Synhimantus hamatus (Linstow 1877)	P	10	56	10	1–48	5	38	1	1–2	1	100	12	12
Synhimantus sp.	P	1	6	1	1	—	—	—	—	—	—	—	—
Procyrnea mansioni (Seurat 1914)	E, P	1	6	1	1	3	23	2	1–2	1	100	1	1
Tetrameres (M.) accipiter (Schell 1953)	P	—	—	—	—	3	23	37	3–103	—	—	—	—
Tetrameres (M.) sp.	P	1	6	3	3	—	—	—	—	—	—	—	—
Tetrameres (T.) sp.	P	7	39	3	1–20	—	—	—	—	—	—	—	—
Porrocaecum depressum (Zeder 1800)	SI	—	—	—	—	4	31	9	1–30	—	—	—	—
Porrocaecum angusticolle (Molin 1860)	SI	—	—	—	—	—	—	—	—	1	100	23	23
Physaloptera sp.	P	2	11	2	1–2	1	8	2	2	—	—	—	—
Gnathostoma sp.	E	1	6	1	1	—	—	—	—	—	—	—	—
Larval spirurids	E, P	9	50	2	1–8	3	23	17	1–50	—	—	—	—
Acanthocephala													
Centrorhynchus kuntzi (Schmidt and Neiland 1966)	SI	14	78	9	1–21	4	31	13	3–28	1	100	11	11
Larval acanthocephalan	E	1	6	1	1	—	—	—	—	—	—	—	—

[a] C = cloaca, E = esophagus, L = liver, P = proventriculus, SI = small intestine, T = trachea

Table 2. Parasitic helminths from American kestrels, sharp-shinned hawks, and Cooper's hawks in Florida.

		Falco sparverius N = 22				*Accipiter striatus* N = 5				*Accipiter cooperii* N = 2			
	Location in Host	Prevalence		Intensity		Prevalence		Intensity		Prevalence		Intensity	
Helminth		Inf.	%	Mean	Range	Inf.	%	Mean	Range	Inf.	%	Mean	Range
Trematoda													
Strigea falconis (Szidat 1928)	SI	1	5	1	—	1	20	2	2	1	50	30	30
Neodiplostomum americanum (Chandler & Rausch 1947)	SI	—	—	—	—	4	80	93	1–291	1	50	93	93
Neodiplostomum attenuatum (Linstow 1906)	SI	—	—	—	—	2	40	9	2–15	2	100	4	2–6
Neodiplostomum pearsoni (Dubois 1962)	SI	—	—	—	—	1	20	8	8	—	—	—	—
Ophiosoma microcephalum (Szidat 1928)	SI	—	—	—	—	—	—	—	—	1	50	9	9
Parastrigea campanula (Dubois and Rausch 1950)	SI	—	—	—	—	1	20	15	15	—	—	—	—
Platynosomum illiciens (Braun 1901)	L	1	5	4	4	—	—	—	—	—	—	—	—
Brachylecithum nanum (Denton and Byrd 1951)	L	3	14	3	2–4	—	—	—	—	—	—	—	—
Echinostoma trivolvis (Cort 1914)	LI	1	5	1	1	—	—	—	—	—	—	—	—
Prosthogonimus ovatus (Rudolphi 1803)	C	2	9	3	1–5	—	—	—	—	—	—	—	—
Nematoda													
Capillaria falconis (Goeze 1782)	SI	1	5	1	1	—	—	—	—	—	—	—	—
Capillaria sp.	SI, LI	—	—	—	—	2	40	3	2–3	2	100	2	2–3
Cyathostoma americana (Chapin 1925)	T	—	—	—	—	—	—	—	—	1	50	1	1
Synhimantus hamatus (Linstow 1877)	P	—	—	—	—	—	—	—	—	2	100	3	3
Dispharynx nasuta (Rudophi 1819)	P	8	36	28	1–125	—	—	—	—	—	—	—	—
Procyrnea mansioni (Seurat 1914)	E, P	4	18	1	1	2	40	1	1	—	—	—	—
Cyrnea semilunaris (Molin 1860)	P	1	5	1	1	—	—	—	—	—	—	—	—
Procyrnea sp.	P	1	5	10	10	—	—	—	—	—	—	—	—
Tetrameres (M.) accipiter (Schell 1953)	P	—	—	—	—	2	40	2	1–3	—	—	—	—
Tetrameres (M.) sp.	P	—	—	—	—	—	—	—	—	1	50	1	1
Porrocaecum depressum (Zeder 1800)	SI	—	—	—	—	—	—	—	—	1	50	2	2
Cardiofilaria pavlovskyi (Strom 1937)	BC	5	23	5	1–18	—	—	—	—	1	50	1	1
Physaloptera sp.	P	2	9	13	8–17	1	20	1	1	—	—	—	—
Larval spirurids	E, P	6	27	5	1–10	—	—	—	—	1	50	1	1
Acanthocephala													
Larval acanthocephalan	E	1	5	1	1	—	—	—	—	—	—	—	—

[a] BC = body cavity, C = cloaca, E = esophagus, L = liver, LI = intestine, P = proventriculus, SI = small intestine, T = trachea.

Table 3. Multiple infections in four species of falconiforms from Florida.

NUMBER OF SPECIES PER INFECTED HOST	*BUTEO LINEATUS* $N = 18$	*BUTEO JAMAICENSIS* $N = 13$	*ACCIPITER STRIATUS* $N = 5$	*FALCO SPARVERIUS* $N = 22$
0	1	2	0	1
1	1	2	1	10
2	0	0	2	7
3	3	2	0	4
4	2	4	1	0
5	1	0	0	0
6	2	0	0	0
7+	8	3	1	0
Mean	5.8	4.7	3.2	1.7

Taft et al. (1993) examined 16 broad-winged hawks from Wisconsin and Minnesota and also found 11 species of helminths.

In contrast, the kestrel averaged only 1.7 species per infected bird, with an almost total absence of the strigeid trematodes characteristic of the other hawks. This finding is confirmed also by Taft et al. (1993), who found only three species of helminths in nine kestrels. The diet of the kestrel consists predominantly of arthropods (Beltzer 1990) and the most prevalent helminth in kestrels, *Dispharynx nasuta,* uses isopods as intermediate hosts. This nematode is more characteristic of galliforms and passeriforms and has been associated with severe proventricular lesions and death (Rickard 1985). The cloacal trematode, *Prosthogonimus ovatus,* also found in Florida only in the kestrel, uses dragonfly naiads as intermediate hosts (Boddeke 1960). Although *P. ovatus* has a broad host range, it has not been reported previously from raptors.

Total helminth intensities in these six species of hawks were comparatively low and no significant lesions were observed. Helminths were not implicated as the cause of death in any of the 75 birds examined. However, species such as *Dispharynx nasuta, Tetrameres* spp., and *Centrorhynchus kuntzi* remain as potential pathogens, especially in juvenile birds.

Although sample sizes of hosts were small, it appears unlikely that larger samples of these protected birds will be available in the future. Conclusions concerning host specificity, geographic distribution, and community structure of raptor parasites will have to be inferred from limited data. Mauritz Sterner of the University of Nebraska State Museum, Lincoln, is assembling a database of raptor helminths and will accept specimens for deposit. The senior author (J.M.K.) would be happy to identify helminths collected by raptor researchers and deposit specimens in appropriate collections.

Table 4. Classification of helminth species of raptors in Florida by host specificity.

HELMINTH SPECIES	SPECIALIST	GENERALIST		COSMOPOLITAN
		RAPTOR	BIRD	
Trematodes				
Strigea falconis		+		
Neodiplostomum americanum		+		
Neodiplostomum attenuatum		+		
Neodiplostomum pearsoni		+		
Ophiosoma microcephalum		+		
Parastrigea tulipoides	+			
Parastrigea campanula		+		
Platynosomum illiciens		+		
Brachylecithum rarum			+	
Brachylecithum nanum			+	
Baschkirovitrema incrassatum				+
Echinostoma trivolvis				+
Microparyphium facetum			+	
Prosthogonimus ovatus			+	
Cestodes				
Cladotaenia globifera		+		
Nematodes				
Capillaria falconis		+		
Capillaria contorta			+	
Cyathostoma americana		+		
Desportesius invaginatus			+	
Synhimantus hamatus		+		
Dispharynx nasuta			+	
Procyrnea mansioni		+		
Cyrnea semilunaris			+	
Tetrameres accipiter		+		
Porrocaecum depressum		+		
Porrocaecum angusticolle		+		
Cardiofilaria pavlovskyi			+	
Acanthocephala				
Centrorhynchus kuntzi		+		

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